# **Desorption of Indigosol Blue from Humic Acid Coated Fe<sub>3</sub>O<sub>4</sub> Particles**

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**Abstract.** Desorption of indigosol blue from humic acid coated  $Fe_3O_4$  (Fe<sub>3</sub>O<sub>4</sub>-HA) was investigated. The desorption had been done with HCl as desorption agent. The purpose of this study was to determine the effect of various concentration HCl on desorption efficiency of indigosol blue from  $Fe_3O_4$ -HA. Desorption was carried out during 60 minutes of contact time. The result confirmed that HCl can be used as desorption agent although complete desorption can not be achieved, the desorption efficiency was 48.52 % with concentration of HCl 1 M.

Keywords: Desorption, Fe<sub>3</sub>O<sub>4</sub>-AH, indigosol blue

## **INTRODUCTION**

Synthetic dyes are usually used in many industries, including textile industries. Most dyes are stable to light, heat, and oxidizing agents. Removal dye from wastewater is a must for textile indutries because its hazardous, especially if the dyes added into water bodies. Currently, many methods like physical or chemical processes are used to treat dye in wastewaters.

Adsorption is one of effective methods for wastewater treatment. This method provide easy to apply, high efficient, low-cost, and the adsorbent can be reused or regenerated. Before regeneration process, the adsorbate had to released from the adsorbent with desorption agent. Desorption is a simple method using desorption agent therefore adsorbate can released.

Humic acid is one of alternative adsorbent for removal dye from aqueous solution because it contains – OH and -COOH which can adsorb adsorbate with chemical or physical interaction. Humic acid in this study was isolated from Riau peat with alkali extraction. The humic acid coated with  $Fe_3O_4$  for enhance the stability and improve the sorption of indigosol blue dye. After adsorption process, indigosol blue desorbed with HCl as agent desorption. HCl rarely be used as desorption of anionic dye and it would be novelty for this study. Desorption result indicated that HCl work as desorption agent because of ion exchange between adsorbent and adsorbate.

#### MATERIALS AND METHODS

## **Materials**

The HA powders used were isolated from Riau peat with alkali extraction method. HA coated  $Fe_3O_4$  nanoparticles

with co-precipitation method. Indigosol blue was purchased from batik store at Kauman, Yogyakarta.

### Procedures

Adsorption was carried out at optimum condition using thermostated shaker. After percentage of adsorption measured, the Fe<sub>3</sub>O<sub>4</sub>-HA was separated from liquid. The saturated Fe<sub>3</sub>O<sub>4</sub>-HA were added into HCl with various concentration 0 M; 0.5 M; 1 M; 1.5 M; and 2 M. Desorption was carried out at room temperature and 60 minutes of contact time using thermostated shaker. The Fe<sub>3</sub>O<sub>4</sub>-HA separated from liquid then indigosol blue in liquid was measured with UV-Vis Spectrophotometer to estimate the desorbed amount of indigosol blue. The percentage of desorption was calculated using equation (Eq. (1))

Percent of desorption = <u>Concentration of indigosol blue desorbed</u> Concentration of indigosol blue adsorbed 100%

(1)

#### **RESULTS AND DISCUSSION**

### Adsorption study

According to Fauzi (2018), adsorption process in this study was carried out at optimum condition. Based on FT-IR result (Figure 1.), (there was difference absorptions between Fe<sub>3</sub>O<sub>4</sub>-HA before adsorption and. There was an absorption at wave number 1049.28 cm<sup>-1</sup> indicated the stretched vibrate S-O from SO<sub>3</sub>- of indigosol blue therefore indigosol blue could be adsorbed by Fe<sub>3</sub>O<sub>4</sub>-HA. Percentage of adsorption reached up to 74.79 %.

## **Desorption study**

Desorption proccess is important to do because adsorbate have to release from adsorbent with desorption agent therefore the adsorbent can be used again. Desorption was done to understand the binding between the adsorbent and the adsorbate while adsorption proccess. In order to desorb the indigosol blue from Fe3O4-HA, HCl with various concentration was selected as desorption agent. The percentage of desorption indigosol blue as seen in Table 1.

Table 1. Percentage of desorption with various concentration of HCl.

C of HCl	% desorption
0	22.59
0.5	25.06
1	48.52
1.5	31.23
2	23.83

From Table 1., HCl could be used as desorption agent of indigosol blue from Fe<sub>3</sub>O<sub>4</sub>-HA although the percentage of desorption achieved less than 50 %. HCl is a strong acid and had been used as desorption agent through ion exchange mechanism. HCl released its H<sup>+</sup> ion and it would made an interaction with SO<sub>3</sub><sup>-</sup> anion from indigosol blue. This interaction also happened between aquades as desorption agent but the H<sup>+</sup> ion from aquades was not strong enough to made an interaction with SO<sub>3</sub><sup>-</sup> anion therefore the result was smaller than using HCl.

Based on FT-IR result (Figure 1.), absorption at wave number 1627.92 cm<sup>-1</sup> shifted to 1620.21 cm<sup>-1</sup> indicated the interaction between –COOH from Fe<sub>3</sub>O<sub>4</sub>-HA and SO<sub>3</sub><sup>-</sup> from indigosol blue decreased therefore the indigosol blue could be released from Fe<sub>3</sub>O<sub>4</sub>-HA. The interaction between Fe<sub>3</sub>O<sub>4</sub>-HA and indigosol blue was electrostatic interaction because indigosol blue could be released although didn't reach complete result. The interaction showed physic interaction between –COOH from Fe<sub>3</sub>O<sub>4</sub>-HA and SO<sub>3</sub><sup>-</sup> from indigosol blue. The other interaction might be happened such as covalent bond between Fe<sub>3</sub>O<sub>4</sub>-HA and indigosol blue because the absorption of stretched vibrate S-O could be seen at FT-IR result.



Figure 1. FT-IR result of (a) Fe $_3O_4$ -HA after adsorption (b) Fe $_3O_4$ -HA after desorption.

## CONCLUSIONS

HCl can be used as desorption agent of indigosol blue from Fe<sub>3</sub>O<sub>4</sub>-HA with maximum result 48.52 % with using HCl 1 M. Based on desorption result, the interaction might be happened between Fe<sub>3</sub>O<sub>4</sub>-HA and indigosol blue was electrostatic interaction and covalent bond.

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